Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information	
Area	3
Title	**Removal of radioactive materials from the seawater in the harbor**
Submitted by	**Cavendish Nuclear Ltd (part of Babcock International Group and previously known as Babcock Nuclear Services Ltd)**

1. Overview of Technologies (features, specification, functions, owners, etc.)

Babcock designed and provided Submersible Caesium Removal Units (SCRU) to reduce the activity within Fuel Cooling Ponds at Magnox Power Stations within the UK. The Units which are designed to be placed within the Fuel Cooling Pond rely on ion exchange (IX) technology based on the selecting the best ion exchange media for the duty.

All UK Magnox station cooling ponds have an effluent treatment plant associated with them incorporating filters to remove particulate, and many also have an ion exchange facility to remove dissolved species, principally Caesium. Over the years power stations using ion exchange filled their storage tanks for spent resin, and new resins have been identified with increased capacity for Caesium which will greatly reduce the volumes of spent resin arising in the future. However, it has not been possible to deploy these new resins in existing plants because of the increased activity of the resins and resulting potential for very high dose rates to operators. A new means of deploying these resins therefore had to be devised, and the submersible Caesium removal plant is the result – as shown in the photo below.

The SCRU can be moved around within the cooling pond using the existing skip handling equipment and placed in a convenient location. It operates under 6m (20ft) of water, utilising the pondwater for shielding. The SCRU module comprises a pump, a pre-filter to screen out particulates, two ion-exchange cartridges containing a Caesium-specific molecular sieve, and a post filter to prevent any potential release of resin into the pond environment.

Units were deployed at Dungeness A, Sizewell A, Oldbury, and Hinkley Point A power stations; and a modified version of the system formed part of the modular Active Effluent Treatment Plant at Hunterston A Power Station.

The resins are contained within cartridges to facilitate the final safe disposal of the IX media; this is a significant issue due to the physical nature of IX media and also the radioactive isotope loading that can be present when the column is exhausted.

Similar units were provided for use at Dounreay in skid mounted forms to treat liquid effluent waste streams arising from the coolant treatment during the decommissioning of the two Fast Reactors on the site. Immobilisation of the waste for to suit UK disposal requirements has been demonstrated by Babcock's Science and Technical Group within its nuclear business.

Babcock believes that this technology could be adapted for the removal of radioactive materials from the seawater in the harbor.

The SCRU design throughput was about 36m^3/hr; this was as a function of the IX bed capacity. For the Pond's limited and contained volume this was adequate, however, for a higher throughput more units would need to be run in parallel or a different size / arrangement of IX media produced. The SCRU worked by continuously re-circulating the fixed pond volume through the ion exchange bed over a long period to reduce the overall activity of the pond (an overall decontamination factor of 50 was achieved on the pond application). At Dounreay an average decontamination factor on the liquid waste streams of approximately 100 was achieved.

2. Notes (Please provide following information if possible.)

- Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)

The process needs to be tailored to the specific water chemistry but the principles have been demonstrated previously in a number of applications.

The pre-treatment requirements may possibly be met through the application of "standard" industrial and municipal water treatment techniques which are in use globally.

- Challenges

The key design challenges relate to the scale of the challenge and the process chemistry associated with treating seawater.

The design may need adapting to suit the harbor application; sediment on the sea bed and the maritime environment may mean the submersible skid design is not appropriate. However, we have demonstrated the capability to take the process principle of the skid and adapt it to a “land based” application.

Pre-filtration would be required to protect the IX media; this is likely to be a standard filter application utilizing a staged cascade of filters of reducing particulate size.

Ion exchange is sensitive to system chemistry; and it would be necessary to carry out process trials to adapt the process to the specific chemistry of the water. This could include changing the IX media selected for the application or including some pre-conditioning in the overall process.

- Others (referential information on patent if any)

【Areas of Technologies Requested】

(1) Accumulation of contaminated water (Storage Tanks, etc.)

(2) Treatment of contaminated water (Tritium, etc.)

(3) Removal of radioactive materials from the seawater in the harbor

(4) Management of contaminated water inside the buildings

(5) Management measures to block groundwater from flowing into the site

(6) Understanding the groundwater flow